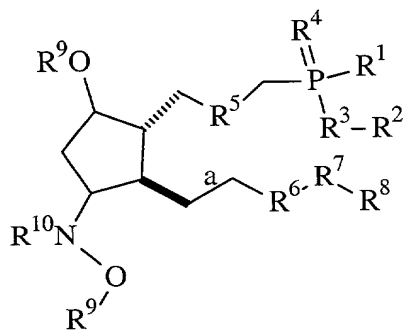


What is claimed is:

1. A 2-decarboxy-2-phosphinico prostaglandin analog having the structure:



$R^1$  is selected from the group consisting of a hydrogen atom, lower monovalent hydrocarbon groups, and lower heterogeneous groups;

$R^2$  is selected from the group consisting of a hydrogen atom, a monovalent hydrocarbon group, a substituted monovalent hydrocarbon group, a heterogeneous group, a substituted heterogeneous group, a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, an aromatic group, a substituted aromatic group, a heteroaromatic group, and a substituted heteroaromatic group;

$R^3$  is selected from the group consisting of an oxygen atom, a sulfur atom, and NH;

$R^4$  is selected from the group consisting of an oxygen atom and a sulfur atom;

$R^5$  is a divalent group selected from the group consisting of a hydrocarbon group, a substituted hydrocarbon group, a heterogeneous group, and a substituted heterogeneous group;

bond a is selected from the group consisting of a single bond, a trans double bond, and a triple bond;

$R^6$  is a divalent group selected from the group consisting of  $-C(O)-$  and  $-C(R^9)(OR^9)-$ ;

$R^7$  is selected from the group consisting of a divalent group having the formula  $-(CR^9(R^9))_p-X-(CR^9(R^9))_q$ , wherein p is an integer from 0 to 3 and q is an integer from 0 to 3, and wherein X is selected from the group consisting of an oxygen atom, a divalent hydrocarbon group, a sulfur atom, SO, SO<sub>2</sub>, and NR<sup>9</sup>;

$R^8$  is selected from the group consisting of a methyl group or a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, aromatic group, a substituted aromatic group, a heteroaromatic group, a substituted heteroaromatic group;

$R^9$  is selected from the group consisting of a hydrogen atom and a lower monovalent hydrocarbon group; and

$R^{10}$  is a lower monovalent hydrocarbon group.

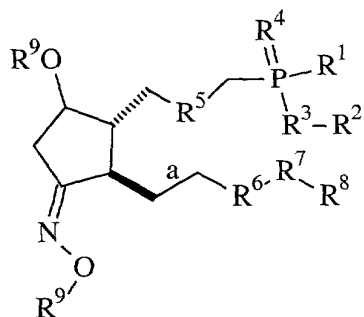
2. A composition for treating hair loss comprising:

A) an active ingredient selected from the group consisting of 2-decarboxy-2-phosphinico derivatives of prostaglandins; optical isomers, diastereomers, and enantiomers of the 2-decarboxy-2-phosphinico derivatives; pharmaceutically-acceptable salts of the 2-decarboxy-2-phosphinico derivatives; biohydrolyzable amides, esters, and imides of the 2-decarboxy-2-phosphinico derivatives; and combinations thereof; and

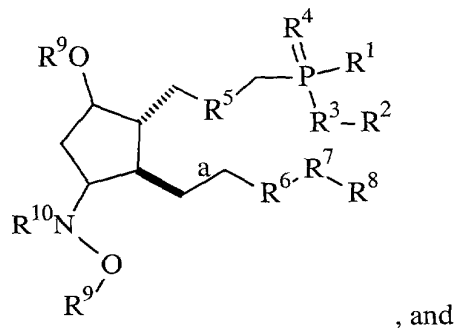
B) a carrier.

3. The composition of claim 2, wherein the 2-decarboxy-2-phosphinico derivative has a structure selected from the group consisting of:

Formula I

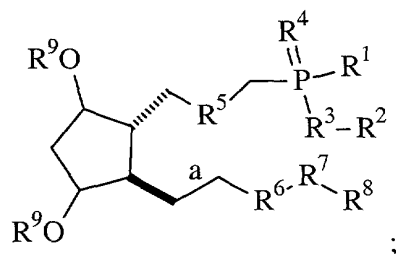


Formula II



, and

Formula III



wherein  $R^1$  is selected from the group consisting of a hydrogen atom, and lower monovalent hydrocarbon groups, and lower heterogeneous groups;

$R^2$  is selected from the group consisting of a hydrogen atom, a monovalent hydrocarbon group, a substituted monovalent hydrocarbon group, a heterogeneous group, a substituted heterogeneous group, a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, an aromatic group, a substituted aromatic group, a heteroaromatic group, and a substituted heteroaromatic group;

$R^3$  is selected from the group consisting of an oxygen atom, a sulfur atom, and NH;

$R^4$  is selected from the group consisting of an oxygen atom and a sulfur atom;

$R^5$  is a divalent group selected from the group consisting of a hydrocarbon group, a substituted hydrocarbon group, a heterogeneous group, and a substituted heterogeneous group; with the proviso that when  $R^5$  is a heterogeneous group,  $R^5$  has only one heteroatom, which is selected from the group consisting of oxygen, sulfur, and nitrogen;

bond a is selected from the group consisting of a single bond, a trans double bond, and a triple bond;

$R^6$  is a divalent group selected from the group consisting of  $-C(O)-$  and  $-C(R^9)(OR^9)-$ ;

$R^7$  is selected from the group consisting of a divalent group having the formula  $-(CR^9(R^9))_p-X-(CR^9(R^9))_q$ , wherein p is an integer from 0 to 3 and q is an integer from 0 to 3, and wherein X is selected from the group consisting of an oxygen atom, a divalent hydrocarbon group, a sulfur atom, SO,  $SO_2$ , and  $NR^9$ ;

$R^8$  is selected from the group consisting of a methyl group, a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, an

aromatic group, a substituted aromatic group, a heteroaromatic group, a substituted heteroaromatic group;

$R^9$  is selected from the group consisting of a hydrogen atom and a lower monovalent hydrocarbon group; and

$R^{10}$  is selected from the group consisting of a hydrogen atom and a lower monovalent hydrocarbon group.

4. The composition of claim 3, wherein  $R^1$  is selected from the group consisting of a hydrogen atom, an alkyl group, a halogenated hydrocarbon group,  $CH_2CH_2OH$ , and  $CH_2CH_2CH_2OH$ .

5. The composition of claim 3, wherein  $R^2$  is selected from the group consisting of H,  $CH_2CO_2H$ ,  $CH_2C(O)NHOH$ , methyl,  $CF_3$ , ethyl, *n*-propyl, isopropyl,  $CH_2CH_2OH$ ,  $CH_2CH(OH)CH_2OH$ , benzyl, and *t*-butyl.

6. The composition of claim 3, wherein  $R^3$  is selected from the group consisting of an oxygen atom and NH.

7. The composition of claim 3, wherein  $R^4$  is an oxygen atom.

8. The composition of claim 3, wherein  $R^5$  has 1 to 5 member atoms.

9. The composition of claim 3, wherein  $R^6$  is  $-C(H)(OH)-$ .

10. The composition of claim 3, wherein X is selected from the group consisting of a single bond, a *trans* double bond, a triple bond, an oxygen atom, a sulfur atom, and  $NR^9$ .

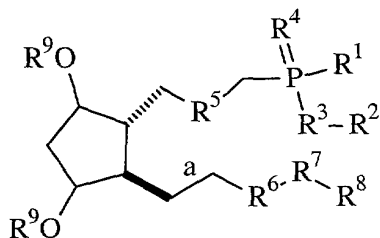
11. The composition of claim 3, wherein  $R^8$  is selected from the group consisting of a monocyclic carbocyclic group, a substituted monocyclic carbocyclic group, a monocyclic

heterocyclic group, a substituted monocyclic heterocyclic group, aromatic group, a substituted aromatic group, a heteroaromatic group, and a substituted heteroaromatic group.

12. The composition of claim 3, wherein  $R^9$  is a hydrogen atom.

13. The composition of claim 3, wherein  $R^{10}$  is a hydrogen atom.

14. The composition of claim 3, wherein the 2-decarboxy-2-phosphinico derivative has the structure:



wherein,  $R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9$ , and bond a are as described above.

15. The composition of claim 2, wherein component B) comprises an ingredient selected from the group consisting of: q) emollients, r) propellants, s) solvents, t) humectants, u) thickeners, v) powders, w) fragrances, water, alcohols, aloe vera gel, allantoin, glycerin, vitamin A and E oils, mineral oil, propylene glycol, polypropylene glycol-2 myristyl propionate, dimethyl isosorbide, and combinations thereof.

16. The composition of claim 2, further comprising component C) an activity enhancer selected from the group consisting of i) a hair growth stimulant, ii) a penetration enhancer, and combinations thereof.

17. The composition of claim 16, wherein component A) is present in the composition in an amount of:  $IC_{50} \times 10^{-2} \geq \% \text{ of component A) } \geq IC_{50} \times 10^{-3}$ , where  $IC_{50}$  is expressed in nanomolar units; component C) is present in an amount of 1 to 20% component C), and a sufficient amount of component B) is present such that the amounts of components A), B), and C), combined equal 100%.

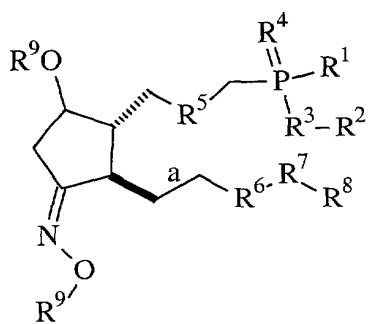
18. The composition of claim 2, wherein component A) is present in the composition in an amount of:  $IC_{50} \times 10^{-2} \geq \% \text{ of component A) } \geq IC_{50} \times 10^{-3}$ , where  $IC_{50}$  is expressed in nanomolar units.

19. A method for treating hair loss comprising administering to a mammal suffering from hair loss, a composition comprising:

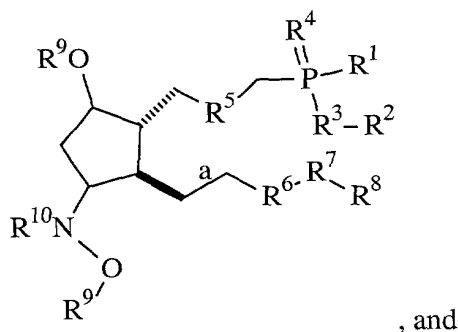
A) an active ingredient selected from the group consisting of 2-decarboxy-2-phosphinico derivatives of prostaglandins; optical isomers, diastereomers, and enantiomers of the 2-decarboxy-2-phosphinico derivatives; pharmaceutically-acceptable salts of the 2-decarboxy-2-phosphinico derivatives; biohydrolyzable amides, esters, and imides of the 2-decarboxy-2-phosphinico derivatives; and combinations thereof.

20. The method of claim 19, wherein the of 2-decarboxy-2-phosphinico derivative has a structure selected from the group consisting of:

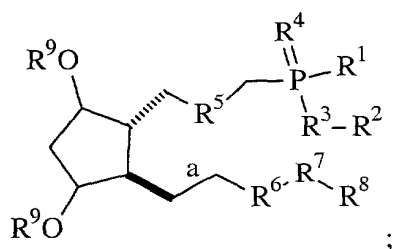
Formula I



Formula II



Formula III



R<sup>2</sup> is selected from the group consisting of a hydrogen atom, a monovalent hydrocarbon group, a substituted monovalent hydrocarbon group, a heterogeneous group, a substituted heterogeneous group, a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, an aromatic group, a substituted aromatic group, a heteroaromatic group, and a substituted heteroaromatic group;

R<sup>3</sup> is selected from the group consisting of an oxygen atom, a sulfur atom, and

R<sup>4</sup> is selected from the group consisting of an oxygen atom and a sulfur atom;

R<sup>5</sup> is a divalent group selected from the group consisting of a hydrocarbon group, a substituted hydrocarbon group, a heterogeneous group, and a substituted heterogeneous group; with the proviso that when R<sup>5</sup> is a heterogeneous group, R<sup>5</sup> has only one heteroatom, which is selected from the group consisting of oxygen, sulfur, and nitrogen;

bond a is selected from the group consisting of a single bond, a trans double bond, and a triple bond;

R<sup>6</sup> is a divalent group selected from the group consisting of -C(O)- and -C(R<sup>9</sup>)(OR<sup>9</sup>)-;

R<sup>7</sup> is selected from the group consisting of a divalent group having the formula -(CR<sup>9</sup>(R<sup>9</sup>))<sub>p</sub>-X-(CR<sup>9</sup>(R<sup>9</sup>))<sub>q</sub>, wherein p is an integer from 0 to 3 and q is an integer from 0 to 3, and wherein X is selected from the group consisting of an oxygen atom, a divalent hydrocarbon group, a sulfur atom, SO, SO<sub>2</sub>, and NR<sup>9</sup>;

R<sup>8</sup> is selected from the group consisting of a methyl group, a carbocyclic group, a substituted carbocyclic group, a heterocyclic group, a substituted heterocyclic group, aromatic group, a substituted aromatic group, a heteroaromatic group, a substituted heteroaromatic group;

R<sup>9</sup> is selected from the group consisting of a hydrogen atom and a lower monovalent hydrocarbon group; and

R<sup>10</sup> is selected from the group consisting of a hydrogen atom and a lower monovalent hydrocarbon group.

21. The method of claim 19, wherein the composition is administered by a route selected from the group consisting of systemic and topical routes.

22. The method of claim 21, wherein the composition is a topical composition in a form selected from the group consisting of solutions, oils, creams, ointments, gels, lotions, shampoos, leave-on and rinse-out hair conditioners, milks, cleansers, moisturizers, sprays, and skin patches.

23. The method of claim 22, wherein the composition is a topical composition further comprising B) a topical carrier, wherein the topical carrier comprises an ingredient selected from the group consisting of q) emollients, r) propellants, s) solvents, t) humectants, u) thickeners, v) powders, w) fragrances, water, alcohols, aloe vera gel, allantoin, glycerin, vitamin A and E oils, mineral oil, propylene glycol, dimethyl isosorbide, polypropylene glycol-2 myristyl propionate, and combinations thereof.

24. The method of claim 19, wherein the composition further comprises C) an activity enhancer selected from the group consisting of i) a hair growth stimulant, ii) a penetration enhancer, and combinations thereof.

25. The method of claim 24, wherein component i) is selected from the group vasodilator, an antiandrogen, a cyclosporin, a cyclosporin analog, an antimicrobial, an anti-inflammatory, a thyroid hormone, a thyroid hormone derivative, and a thyroid hormone analog, a non-selective prostaglandin agonist, a non-selective prostaglandin antagonist, a retinoid, a triterpene, and combinations thereof.

26. The method of claim 24, wherein component ii) is selected from the group consisting of 2-methyl propan-2-ol, propan-2-ol, ethyl-2-hydroxypropanoate, hexan-2,5-diol, polyoxyethylene(2) ethyl ether, di(2-hydroxypropyl) ether, pentan-2,4-diol, acetone, polyoxyethylene(2) methyl ether, 2-hydroxypropionic acid, 2-hydroxyoctanoic acid,



propan-1-ol, 1,4-dioxane, tetrahydrofuran, butan-1,4-diol, propylene glycol dipelargonate, polyoxypropylene 15 stearyl ether, octyl alcohol, polyoxyethylene ester of oleyl alcohol, oleyl alcohol, lauryl alcohol, dioctyl adipate, dicapryl adipate, di-isopropyl adipate, di-isopropyl sebacate, dibutyl sebacate, diethyl sebacate, dimethyl sebacate, dioctyl sebacate, dibutyl suberate, dioctyl azelate, dibenzyl sebacate, dibutyl phthalate, dibutyl azelate, ethyl myristate, dimethyl azelate, butyl myristate, dibutyl succinate, didecyl phthalate, decyl oleate, ethyl caproate, ethyl salicylate, isopropyl palmitate, ethyl laurate, 2-ethyl-hexyl pelargonate, isopropyl isostearate, butyl laurate, benzyl benzoate, butyl benzoate, hexyl laurate, ethyl caprate, ethyl caprylate, butyl stearate, benzyl salicylate, 2-hydroxypropanoic acid, 2-hydroxyoctanoic acid, dimethyl sulfoxide, N,N-dimethyl acetamide, N,N-dimethyl formamide, 2-pyrrolidone, 1-methyl-2-pyrrolidone, 5-methyl-2-pyrrolidone, 1,5-dimethyl-2-pyrrolidone, 1-ethyl-2-pyrrolidone, phosphine oxides, sugar esters, tetrahydrofurfural alcohol, urea, diethyl-m-toluamide, 1-dodecylazacycloheptan-2-one, and combinations thereof.

27. The method of claim 21, wherein the composition is a topical composition locally administered on the skin once per day.

28. The method of claim 27, wherein the composition is administered once per day for 6 to 12 weeks.

29. A mascara composition comprising:

A) an active ingredient selected from the group consisting of 2-decarboxy-2-phosphinico derivatives of prostaglandins; optical isomers, diastereomers, and enantiomers of the 2-decarboxy-2-phosphinico derivatives; pharmaceutically-acceptable salts of the 2-decarboxy-2-phosphinico derivatives; biohydrolyzable amides, esters, and imides of the 2-decarboxy-2-phosphinico derivatives; and combinations thereof,

dd) a water-insoluble material,

ee) a water-soluble, film-forming polymer,

ff) a wax;

- o) a surfactant;
- gg) pigment; and
- s) a solvent.

30. A method for darkening and thickening hair comprising applying to growing hair and skin, a composition comprising:

A) an active ingredient selected from the group consisting of 2-decarboxy-2-phosphinico derivatives of prostaglandins; optical isomers, diastereomers, and enantiomers of the 2-decarboxy-2-phosphinico derivatives; pharmaceutically-acceptable salts of the 2-decarboxy-2-phosphinico derivatives; biohydrolyzable amides, esters, and imides of the 2-decarboxy-2-phosphinico derivatives; and combinations thereof; and

B) a carrier.

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